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ABSTRACT

This self-instructional manual presents basic information about computers and their capabilities in a series of lessons, each of which contains a list of learner objectives and a series of true-false self-check exercises. The lessons cover: (1) what a computer is and what it can do, and the reasons why computers are used; (2) computer types and sizes; (3) the growth in the number of computer users; (4) what computer literacy is; (5) the hardware and software components of a computer system; (6) selection of a computer system, including hardware and software selection; and (7) applications and systems software, computer languages, and the development of programs. A brief discussion of trends in the computer industry is also provided, as are a 94-item glossary and a list of the correct answers to the self-check exercises. Supplements describing the history and future uses of computers conclude the manual. (ESR)

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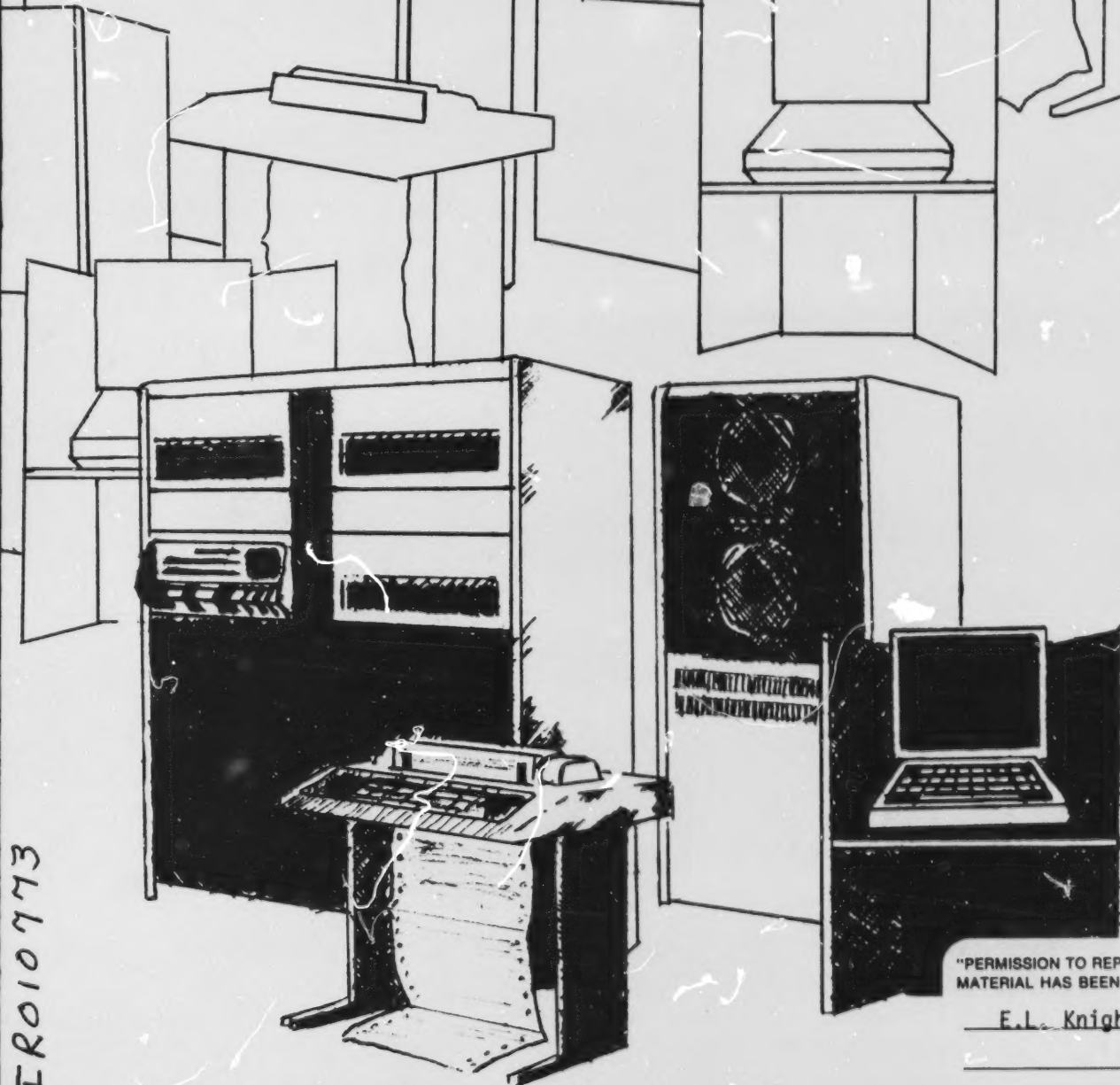
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COMPUTER LITERACY



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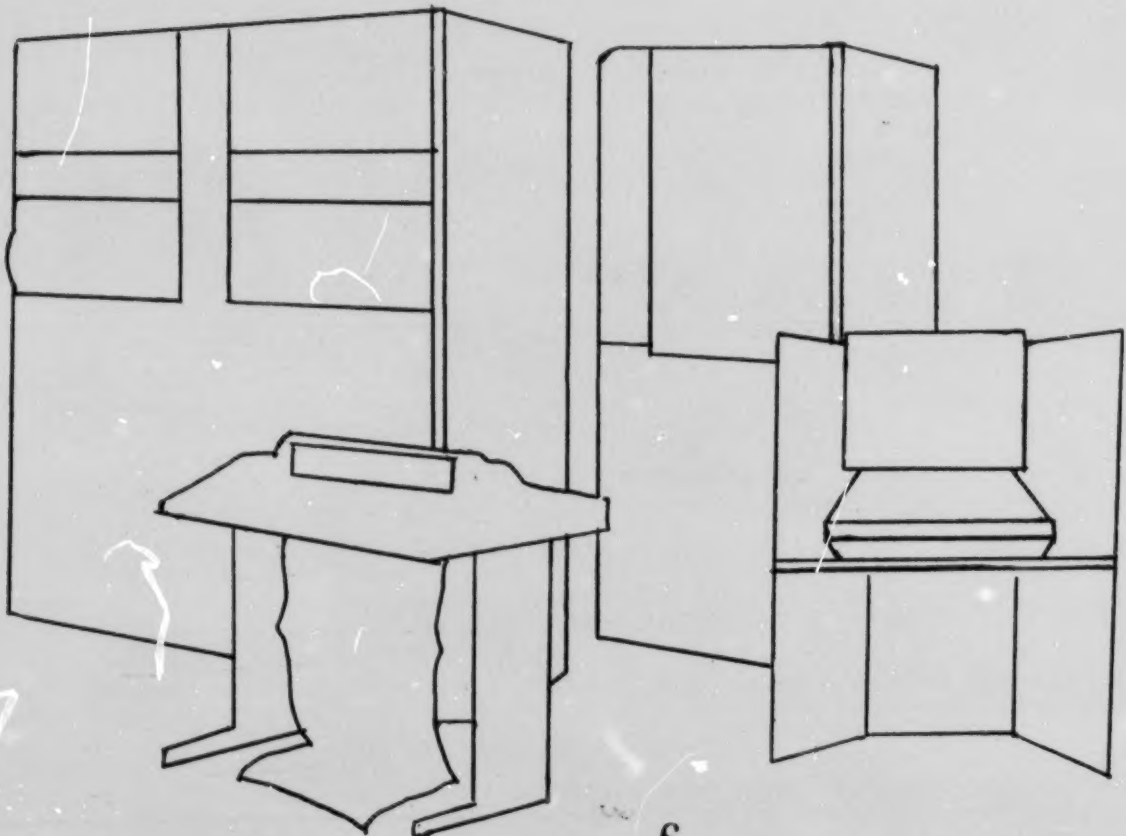
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FOREWORD

The "information revolution" that futurists have long predicted is upon us. It brings with it the promise of dramatic changes in the way people live and work . . . perhaps even in the way they think.

We who are members of the education community are challenged as we have not often been challenged before to be participants in building a computer-oriented society. Helping our students to become computer literate (i.e., to have a sound knowledge of the functions of computers and to be familiar with computer terminology) is essential to preparing them for their lives after their formal education.

Our task is to prepare students to cope with the changes brought about in the computer-oriented society. The challenge is "not impossible" though "somewhat awesome" and "definitely exciting"!



INTRODUCTION

The Program Planning and Development Section of the Office of Vocational Education recognizes the importance of helping all students become computer literate. The development of this manual was a major objective of the Program Section during 1982-83. The manual provides instructors with a practical approach to providing students with a basic knowledge of computers and their capabilities. Our sincere hope is that you will find this manual useful and that it will contribute to your efforts in preparing students to meet the challenges of a computer-oriented society.

We gratefully acknowledge contributions of the following persons: Chris Haff, Business Education Instructor, Kershaw Vocational Center, who served as a field reviewer; Andrea Kelly, State Supervisor, Business Education, who provided resource materials; and Barbara James, Consultant, Health Occupations, for assisting with coordination activities.

Any comments or suggestions you may have about the document will be appreciated.

Anne L. Matthews, Chief Supervisor
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Office of Vocational Education



SECTION I

Learner Objectives

Upon completion of Section I, you should be able to:

1. identify the three basic operations that all computers perform;
2. list three important reasons for using a computer;
3. define the term "programming".

A computer is simply an electronic device designed to perform arithmetic and logical operations with little human intervention. Regardless of the size, most computers can perform basically the same functions which include:

1. input/output operations,
2. arithmetic operations, and
3. logical operations.

The uniqueness of the computer stems from the fact that these operations are performed quickly and accurately, with little assistance from the user.

One of the basic reasons computers are used is that they perform at such a high rate of speed. For this reason, computers were first developed to be used in applications in which time was a critical factor. Consequently, their initial

What is a Computer?

Why are Computers Used?

use was directed at solving mathematical calculations. A second benefit is their ability to store vast amounts of data in an unusually small space. Another powerful benefit derived from the use of computers is their reliability in performing operations quickly.

In its simplest form, a computer has the ability to input and output information. In addition, it has the ability to perform arithmetic operations and/or make logical comparisons. These operations are carried out under the direction of a program.

By definition, a computer PROGRAM is simply a set of instructions. We can develop a set of instructions that will allow the computer to input* the data, to process** the data, and to output*** the information. All these operations are performed at an extremely high speed allowing the user to process large quantities of information quickly and accurately.

What can a Computer do?

*to input--to enter the data for processing

**to process--to perform the calculations and make logical decisions

***to output--to deliver the results



Self-Check

- T F 1. Computers require considerable assistance from the user.
- T F 2. All computers can perform basically three operations.
- T F 3. A computer program is simply a set of instructions.



Learner Objectives

Upon completion of Section II, you should be able to:

1. name four characteristics that differentiate computers;
2. identify the distinguishing differences among the types of computers.

Many types and sizes of computers are available, from ANALOG (which measures) to DIGITAL (which counts and calculates) to micros, minis, and mainframes. These computers have the same basic capabilities. They can, however, be differentiated according to the following characteristics:

- 1) the number of users,
- 2) the number of input and output devices,
- 3) the speed of processing,
- and 4) the size of the internal memory.

MICROCOMPUTER

The MICROCOMPUTER is most often seen in advertisements for personal or home computers and is widely used in schools across the country. It consists of a processing unit which has a screen and a keyboard attached to it. (The keyboard looks just a typewriter keyboard.) The keyboard allows for input of information and the screen displays the output. The microcomputer is a

SECTION II

Computer Types and Sizes



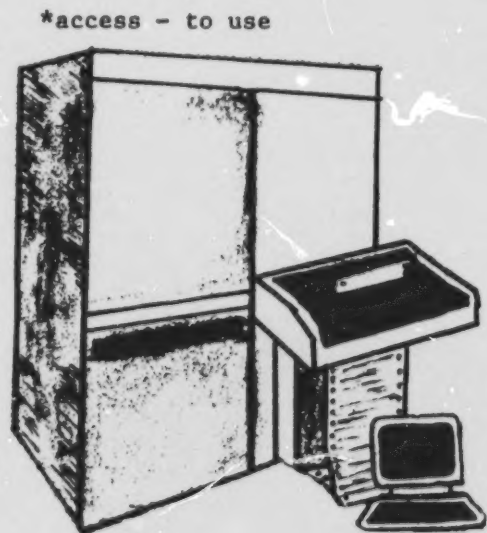
rather small device—both in size and capability.

MINICOMPUTER

The MINICOMPUTER is next in line to the microcomputer. The main difference between the two is that the minicomputer allows for more than one individual to access* its processing capabilities at the same time. Also, the minicomputer allows for flexibility in respect to

- a) the amount of memory that may be expanded and
- b) the type of input and output devices that may be attached.

Finally, the user of a minicomputer may choose from a variety of programming languages which are made available by the manufacturer.



MAINFRAME

The largest sized computer is the MAINFRAME. This device allows for a considerably greater number of users than the other computers. It also has the flexibility of more numerous programming languages. With the expanded number of available programming languages, the variety of users for this type of system increases.

Since all computers basically perform the same tasks, why do we have various sizes? The answer



to this question can be addressed by reviewing the uses of computers.



Self-Check

- T F 1. The largest sized computer is referred to as a microprocessor.
- T F 2. The manner in which computers are differentiated is based upon their physical size.
- T F 3. The microcomputer is most often associated with home or personal use.
-

SECTION III



Learner Objectives

Upon completion of Section III, you should be able to:

1. identify various users of computers;
2. define the term "data processing."

Computers were primarily developed to perform mathematical operations. Mathematicians found it necessary to have some type of device to allow them to do their calculations within a reasonable time limit. While adding machines and calculators were accurate, they lacked speed.

As computers were developed and improved, their costs were reduced, and people started seeing additional applications for computers. Business people, for example, realized that computers could process the mathematical operations in their accounting systems. The term "data processing" was formulated primarily by these business users.

Continuous expansion of technology allowed computers to become an economic reality for most individuals. As a result, the availability of

**Growth in
Number of
Computer
Users**

computers to potential users has rapidly increased.

Through continuous evaluation on the part of users, new computer applications have developed. One of the most notable applications has occurred in the area of word processing. An application using computers to process alpha-numerical information (letters, numbers and special characters) instead of solely numerical information (numbers only) was developed.

This capability reduced the amount of time needed to perform the routine tasks involved in the preparation of documents during the various stages of correction/revision, storage, and retrieval.

Almost every profession and trade and every home and every school has, or will see, applications of computers in some manner or form. Approximately 80 percent of the computers being used today can be found in the business world. A person who is planning to enter the business world in some capacity and who has no knowledge of the computer will be as illiterate as a person today who can not read or write. It is anticipated that by 1990 approximately 80 percent of the homes in the United States will own

a home computer, and a member of each household will have to be familiar with computers. As a result, computer training programs must be developed for new and future users in order to erase misconceptions regarding what a computer is and how it may be used.



Self-Check

- T F 1. The cost of computers has increased during the years since they were first developed.
- T F 2. The primary users of computers today are mathematicians.
- T F 3. It is anticipated that by 1990 approximately 80 percent of the homes in the United States will own a home computer.
-

SECTION IV



Learner Objectives

Upon completion of Section IV, you should be able to:

1. differentiate among the terms computer awareness, computer literacy, and computer fluency.

The widespread availability of computers has created the need to describe the knowledge needed by individuals so that they can use computers with some degree of confidence. Recently a term has been appearing in publications that indicates a level of literacy necessary for users of computers. The term computer literacy is not yet defined in dictionaries; but its meaning has a far-reaching influence on nearly every facet of our lives.

Generally defined as an understanding of computers and the ability to use one to some degree, computer literacy continues to evolve in definition. Educators and lay persons are struggling to sort out all that computer literacy includes. Most authorities agree, however, that computer literacy: 1) dispels fears and myths associated with computers, 2) communicates knowledge about handling information,

**What is
Computer
Literacy?**

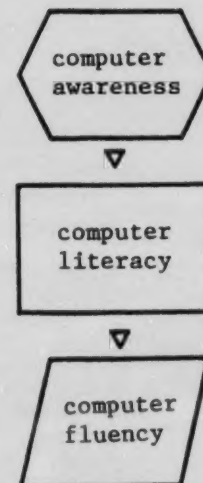
3) develops skills in using and programming a computer, 4) develops procedural learning, and 5) addresses the ethical and societal issues raised by computing.

Computer literacy is only one of three levels in the development of computers. These levels are: 1) computer awareness, 2) computer literacy, and 3) computer fluency.

Computer awareness may be defined as the level at which an individual acknowledges the existence of computers and recognizes computer applications. Computer literacy goes a step further: it assures knowledge of what a computer is and a more detailed description of its uses and applications. The final level, computer fluency, involves the skills necessary to communicate with--that is, to give instructions to--a computer.

It may well be that the majority of the population possesses computer awareness; however, the percentage that is computer literate is very small! Manufacturers of computer systems are trying to educate potential consumers of computers to a computer literate level.

Those consumers who actively pursue a career in computers will reach the level of computer flu-



ency. A good example is the individual who is involved in direct communication with a computer --a PROGRAMMER.

When computer literacy is achieved, it will have a significant influence on the lives of everyone. No longer will persons be intimidated when a computer system is introduced into their working environment. No longer will there be an aura of mystery surrounding those individuals who deal with computers. By eliminating the "mystical cloud" that envelopes computers, an increased number of potential users will be encouraged and trained.



Self-Check

- T F 1. A primary goal of computer literacy is to dispel the fears associated with computers.
- T F 2. Computer awareness involves the skills necessary to communicate with and to give instructions to a computer.
-



SECTION V

Learner Objectives

Upon completion of Section V, you should be able to:

1. differentiate between the terms hardware and software;
2. identify the purpose of input devices;
3. name the three subunits of the central processing unit;
4. name two output devices;
5. define what is meant by computer languages;
6. list three types of computer languages available;
7. identify the common features of all computer languages.

All computer systems consist of two parts: the first part is referred to as hardware and the second as software. **HARDWARE** is the term used to describe the actual physical devices (equipment) in a computer system; on the other hand, the term **SOFTWARE** refers to the programs or sets of instructions used to direct the operations of the hardware.

HARDWARE

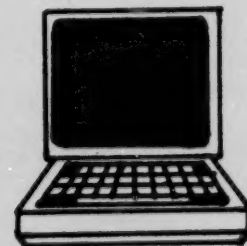
A typical computer system consists of three major components: input devices, central processing unit (CPU), and output devices.

Components of a Computer System

INPUT DEVICES

Input devices allow for data to be taken into the system, translated into a computer readable form, and placed in the memory of the central processing unit. A common input device is a CARD READER that takes a paper card which is perforated by a keypunch machine and translates its holes into electronic signals which are then sent to the central processing unit.

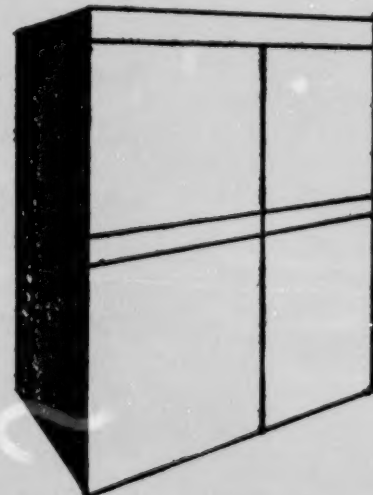
Today a more common input device is a CATHODE RAY TUBE (CRT). Basically, the CRT consists of a keyboard that resembles a typewriter and a screen that looks like a television. The CRT has an advantage over the card in that as data are entered, information is displayed on the screen, allowing for the detection of any errors through observation. Other types of input devices are magnetic tape and magnetic disk.



CENTRAL PROCESSING UNIT

The CENTRAL PROCESSING UNIT (CPU) consists of three smaller units: 1) INTERNAL OR PRIMARY MEMORY 2) the ARITHMETIC-LOGIC UNIT, and 3) the CONTROL UNIT.

Internal memory, as the term implies, is that area in which information may be stored and used



by the arithmetic/logic unit or come under the direction of the control unit. The important fact to note is that each location in memory is given an address by which the information may be recalled and used by the other units in the CPU.

The arithmetical unit/logical unit allows for simple arithmetic operations to be performed; namely, addition, subtraction, multiplication, and division. These are essentially the only mathematical capabilities of the machine.

In addition to performing calculations, the arithmetic/logic unit allows questions to be asked and answered. The only type of questions that may be presented, however, must be in BINARY FORM, (i.e., requiring a "true/false" or a "yes/no" answer). Since the power source of a computer system is electricity, which only has the properties of positive and negative charges, one can understand the reason why the question has to be in binary form.

The control unit is that unit of the CPU which distinguishes a computer from a calculator. This unit allows for a set of stored instructions to be activated, thereby causing the input of raw data (unprocessed data), the processing

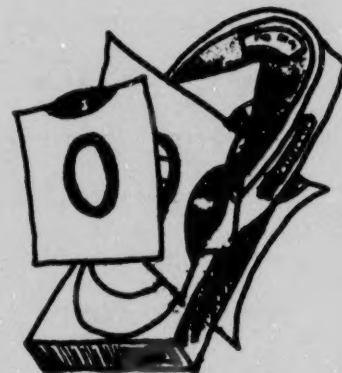
of that raw data arithmetically and/or logically, and the output of information (processed data). The control unit has as its basis the software, or computer program. The program controls the operations of the other units.

OUTPUT DEVICES

After information has been summarized, tabulated, or processed, the group of output devices allows for information to be presented in some form to the user. A common type of output device is a printer (a mechanical device) which simulates a typewriter. This device allows information to be printed on paper.



Other types of devices for output are those that may also be used for input: MAGNETIC TAPE and DISK. The reason for using these devices is that information which is outputted from one program may be used as input to other programs, allowing for further tabulation.



The speed of the computer is fully realized in the central processing unit. Technology has provided for information to be stored, processed arithmetically and/or logically, and controlled at very high speeds--at billionths of a second! The areas lacking speed, however, are the input and output devices. Most of these devices still

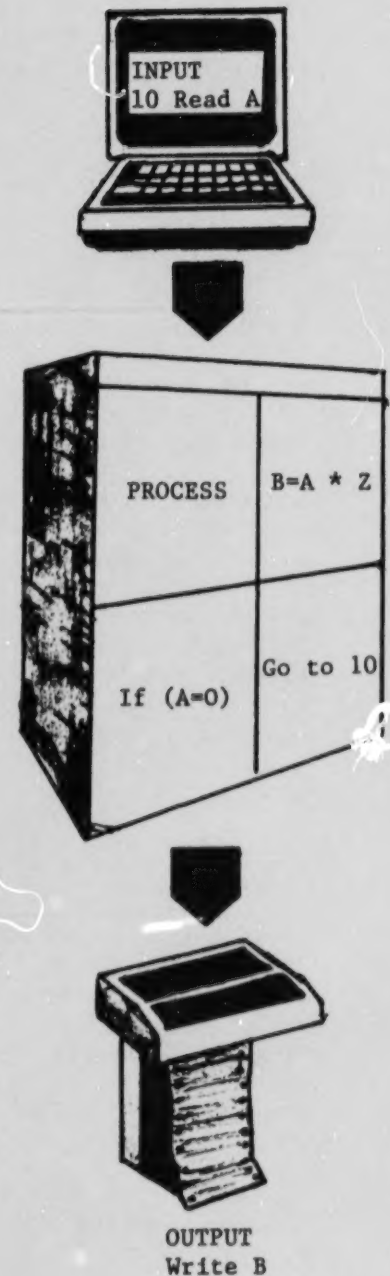
rely on some type of mechanical operations and do not allow the speed of the central processing unit to be fully realized. The CPU is constantly waiting for data to be inputted for processing and for information to be outputted in order that it may output further information.

SOFTWARE

Now that we have an understanding of the hardware required in a computer system, we need to examine the functions of software. This area of computer technology is one in which most development will occur in the future. Software refers to the various computer programs written to perform certain operations. A program, again, is defined as a set of instructions. Since the computer can only understand electronic impulses, the instructions which we provide must be in that form--the machine language.

COMPUTER LANGUAGES

When computers were first developed, the information was converted into a format that the machine could read; however, the major advantage of using a computer--speed--was lost. A great deal of time had to be spent in conversion of instructions into MACHINE LANGUAGE.



Realizing the time problem, developers of computers looked to other disciplines and found in the area of communication the same problem. When faced with a communication process between two individuals, each of whom used a language not understood by the other, it was necessary to bring in a third individual who had knowledge of both languages to act as an interpreter.

The designers of computers, and especially those of software, replicated this interpreter by developing what is referred to as a COMPILER. A compiler is no more than a bilingual dictionary that takes what is given in one language and translates it into another language. The necessity of this translation process, from computer language to machine language, requires that a compiler exist for every computer language available.

Basically a computer language is a symbolic language; that is, we try to represent in some symbolic form the type of instructions we are asking the computer to process. Examples of these symbolic languages are FORTRAN, COBOL, RPG, PL1, BASIC, and the interactive languages, such as APL.

TYPES OF COMPUTER LANGUAGES

But why do so many different types of computer languages exist? To answer this question, we must look at the uses of computers by the various user populations. The FORTRAN language, for example, was developed primarily for mathematicians; it is a symbolic language that allows for representation of mathematical formulations. The COBOL language was developed primarily for the business area; it is an acronym for Common Business Oriented Language. RPG is Report Program Generator language, a symbolic language formulated to facilitate the ways that information can be outputted. BASIC is a language that was developed primarily for instructional purposes; it is an acronym for Beginners All-Purpose Symbolic Instruction Code. As the term implies, BASIC is simple and easy to understand.

COMMON FEATURE OF ALL COMPUTER LANGUAGES

The major feature of all these languages, and the one which should be emphasized, is the fact that all of them can basically ask the computer to do the same task, but they do so in a different language; that is, a program instruction to input, to output, to operate arithmetically, to operate logically, and to control the execution of other types of instructions. While meeting a

unique need of a particular user, each language uses these same five kinds of program instruction.

Since the computer is limited in the type of instructions it can execute, any instruction has to be simplified in order that it may be represented in one of the five types of instructions acceptable to the computer. This task is not as simple as it sounds, but is, rather, a task similar to rewriting a paragraph composed on a tenth grade reading level to be understood by a student on a third grade reading level. Simplicity is the key to sound instruction.

In addition to being written simply, instructions must be executed in the logical order necessary to generate the desired output. A great deal of time is spent developing the logical process of instruction execution through the use of diagrams such as FLOWCHARTS and HIPO/charts. These diagrams require the user to simplify the instructions which the computer is asked to use to perform a task and to indicate the order in which the instructions should be executed.

An ALGORITHM is a set of instructions operated in a repetitive manner. Remember: the set of

instructions can include an instruction to input, to output, to process arithmetically, to process logically, and to control the processing of the other instructions. The number of times each of these types of instructions occurs depends on the problem or the task.



Self-Check

- T F 1. Hardware consists of three major components: input devices, central processing unit, and software.
- T F 2. The most common type of input device is a CRT.
- T F 3. The control unit in the CPU differentiates a computer from a calculator.
- T F 4. The most common type of output device is magnetic tape.
- T F 5. A program is defined as a set of instructions.
- T F 6. The purpose of a compiler is to convert into machine language the instructions a programmer is writing in a computer language.
- T F 7. The acronym BASIC Stands for Beginners All-Purpose Symbolic Instruction Code.
- T F 8. The common feature of all computer languages is to undertake the steps necessary to input, to output, to operate arithmetically, to operate logically, and to control the execution of other types of instructions.
- T F 9. An algorithm is defined as a specific type of programming language.



Learner Objectives

SECTION VI

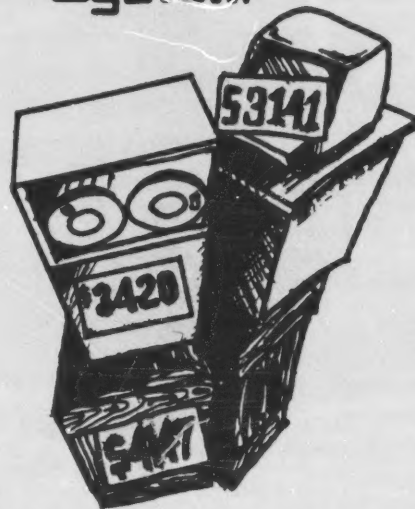
Upon completion of Section VI, you should be able to:

1. identify the specific needs related to the type of computer system to be selected;
2. list the criteria for the selection of hardware;
3. list the criteria for the selection of software.

Now that we have an understanding of what a computer is, what it can do, and some of the terms associated with computers, how do we go about selecting a computer and the programming language to use with that computer? This question can only be answered by determining what the computer system is to do.

Much time and effort must go into a planning process. This process should examine what is being undertaken in a manual operation and determine whether these operations can be replicated by the computer. If so, the cost of operations must be weighed against the savings realized by using the computer. Since the major advantages to using a computer are speed and the ability to process and store large quantities of

Selection of a Computer System



data, one important question should be addressed:

"Is time a critical factor?" Specific needs must then be determined.

IDENTIFICATION OF SPECIFIC NEEDS

Need is a primary factor in the selection of any computer system. The following list cites several areas of need and/or uses for computers in an educational setting.

1. Drill and Practice represents a form of interactive computer assisted instruction. The student responds in a rather quick fashion to brief items or questions (that is, a sort of flashcard format). The computer provides feedback regarding the correctness of the student's answer. The feedback may adapt to individual students by varying the number of items or the frequency of the stimuli, based on the student's responses. School subjects such as mathematics, spelling, and grammar particularly lend themselves to practice drills.

2. Tutorial Programs provide paragraph-like material. These programs are usually characterized by an abundance of textual material and are used in self-paced instructional programs. Entire courses, including reviews and tests, are available. The new information is systematically presented to the students with "branching" options, depending on the student's response.

3. Problem-Solving Programs typically help the student in the application of principles or rules for certain problem situations. The computer completes the complex calculations while the student repetitively supplies data to manipulate the rule or principle being taught. (These programs are usually short algorithms.)

4. Programming involves the use of a computer language to provide the proper instructions which control the computer.

Perhaps the major single use of the computer in instruction is in the teaching of computer programming.

5. Model Simulation Phenomena involve uses of a very complex nature in which random events are introduced to add realism to interaction. The student is presented with situations requiring decision making and the subsequent chain of events depends on the user's decisions. The simulation is a valuable strategy when one needs to compress time, to avoid dangerous phenomena, or to escape the use of expensive equipment. Usually the simulation imitates a real problem, such as the student's assuming the role of a nuclear reactor operator faced with cooling problems leading to a possible meltdown.

6. Testing by Computer permits the educator to exercise options not available with traditional testing methods. Items may be administered in order to continue to compile responses which will improve testing reliability. Often tests may be constructed easily from individual programs. Diagnostic tests may be collapsed into short testing sessions. A special benefit is that tests may be scored simultaneously.

7. Computer Managed Instruction is characterized by a record keeping system relating to assignments and student performance. The computer administers tests, assigns study activities, and maintains records of individual performance and progress. Computer managed instruction also provides for the indexing of traditional instructional materials which can then be accessed when needed.

8. Data Analysis is a programming package which provides for the arithmetical computation of statistics. Educators may use data analysis to arrive at averages, standard deviations, quartile ranks, etc.

9. Information Retrieval is a much-used application in social and physical sciences as well as in the humanities. In this application, the computer is used to select information from a large storage medium according to certain predetermined rules.

Typical applications are literature searches, selected mailing lists, and fact finding.

10. Word Processing provides a function in which the computer permits easy manipulation of text for reports, essays, and other paragraph material. This strategy may facilitate the student's preparation of essays by permitting easy insertion of text, correction of spelling and punctuation, or reorganization of presented material without the necessity of completely rewriting.

11. Computer Literacy entails an understanding of the use of the computer, computer hardware, software, and data processing capabilities. Students today will be at a distinct disadvantage in their working and personal lives if they do not graduate "computer literate"; for computers are fast assuming a vital, integral role in society.

These categories reflect only a few of the needs for using computers in an educational environment. These applications can also be extended into other areas of our personal and working lives. Each need will help to determine the type of equipment needed.

Table 1 lists the various needs for computers and the different characteristics of a computer. From this table we can examine exactly what characteristics are applied to each need. Looking at Table 1, no definite characteristic is shown as predominant for all needs. Again, the needs of the user determine the type of computer system to obtain.

TABLE 1
MATCHING NEEDS WITH CHARACTERISTICS

	NEEDS							
	Drill and Practice	Tutorial	Problem Solving	Program- ming	Simula- tion	Testing	Computer Literacy	Other
Usable Memory (RAM)	4-8K	16-32K	8K	8K	8-32K	16-32K	4-8K	16-64K
Lower Case Characters	No	Yes	No	No	Yes	Yes	No	Yes
Cassette (C) and/or Disk (D)	C	D	C	C	D	D	C	D
Graphics	No	Yes	Yes	No	Yes	No	No	No
Hardcopy	No	Yes	No	Yes	No	Yes	Yes	Yes
Decimal (Non Integer) Arithmetic	No	No	Yes	Yes	Yes	No	No	Yes
Other Programming Languages	No	No	No	Yes	No	No	No	Yes
Files	No	Yes	No	No	Yes	Yes	No	Yes
Communication Capability	No	Yes	No	Yes	Yes	Yes	No	Yes
Number Lines Display	12	24	16	24	24	16	12	24

CHARACTERISTICS

Hardware Selection

After determining the needs for a computer, the next step is to determine what type and model of computer meets those needs. Should it be a microcomputer, a minicomputer, or a mainframe? Should it be purchased or leased? Can it be upgraded for flexibility in the future? Does it have a ready market for resale? What are the one-time and the recurring costs? These and other questions involve the very detailed process of evaluation. Here again, it all depends on the needs of the individual and the cost benefits derived from the use of the computer.

BUY OR LEASE?

An alternative to purchasing a computer system is the purchase of time on an existing system. This practice, called time sharing, is especially prevalent when the owner of a large mainframe has not completely utilized the full capabilities of the computing equipment and is willing to lease this excess time to outside users. This approach is very economical for the time sharer; however, it limits the user's capabilities of flexibility in using the computer system. In most cases, the only requirement for time sharing is the purchase of input

and output devices and the leasing of lines connecting these devices to the central processing unit. The CPU does not need to be located physically within the proximity of the user. Through the use of telecommunications, the central processing unit may be located in any area and connected via telephone line or satellite.

When a decision is made to purchase or lease a computer system, one of the first pieces of data that is provided to the consumer by the manufacturer is a description of the system. This description usually includes: the size of the memory, the speed of processing, and the number of input and output unit channels available on the system.

HOW LARGE A MEMORY?

Memory is measured in BYTES, more notably, in KILOBYTES, represented by "K". A "K" consists of 1,024 bytes or characters (letters, numbers, or special symbols). In advertisements for computers, you may notice "offered with 48K of memory." This phrase is interpreted to mean that the computer has approximately 48,000 memory cells available for use in internal memory. This memory is referred to as RAM, which stands for Random Access Memory. Data

which are independent of sequential order can be stored and recovered.

In some cases, a listing is provided for an additional memory which is referred to as ROM, or Read Only Memory. The primary difference between RAM and ROM is that with ROM the user cannot alter the contents of the memory cell. The contents are established by the manufacturer in a prescribed method.

To eliminate the potential problem of not allowing the user to change the contents of ROM, manufacturers have produced what is referred to as PROM--an abbreviation for Programmable Read Only Memory. The primary difference between PROM and ROM is that with PROM the contents (or the access to change the contents) of the memory cell are under program control.

Because software programs require varying amounts of internal memory to execute properly, it is imperative to choose a memory size that adequately handles the software selected.

The decision to purchase or lease a certain type of hardware is a monumental task in itself; however, the selection of the software is of much more importance and should be evaluated before

**Software
Selection**

the purchase of any hardware. The largest growth in computer literacy will be in the area of software. The reason for this increase is that the availability of software dictates in large measure the possible uses in computer systems. Some users and manufacturers have noted that, possibly in future situations, computer companies will donate the hardware if the consumer purchases the software.

Software is an expensive item in comparison to the cost of the complete computer system. In selecting software, a consumer has two alternatives: 1) produce the software needed or 2) buy existing software. The first alternative is not costly unless the user considers the time involved. The major advantage in developing one's own software is that programs can be developed which are more suitable to specific needs. The amount of time spent in the development and implementation of the software may, however, be prohibitive.

If time is a critical factor, the consumer may decide to purchase software. The number of companies offering software for all sizes of computers, from the micros to the mainframes, is extensive and increasing daily. How then does one evaluate software?

The combination of hardware and software comprises a computer system. As with the selection of hardware, the selection of software is based on the unique needs of the user.

A software package consists of a number of different programs, each program having a specific use. The programs can, however, be classified into two broad groups: applications software and systems software. In some cases, the decision regarding which type of software can be used--either applications or systems--is determined by the manufacturer. For example, not every software package is compatible with the different types of hardware.



Self-Check

- | | | |
|---|---|--|
| T | F | 1. Need is a primary factor in the selection of any computer system. |
| T | F | 2. Computer managed instruction typically helps the student in the applications of principles or rules for certain problem situations. |
| T | F | 3. The selection of computer hardware is independent of the selection of the software that will be used. |
| T | F | 4. Purchasing rather than leasing a computer system allows for greater flexibility in the future. |
| T | F | 5. A major component to consider in the selection of computer hardware is the amount of memory. |

- T F 6. Software is as expensive or more expensive than hardware for a number of computer systems.
-



SECTION VII

Learner Objectives

Upon completion of Section VII, you should be able to:

1. differentiate between the terms applications software and systems software;
2. apply the appropriate steps to evaluate applications software and systems software;
3. identify the primary use of four major programming languages;
4. list the steps followed in the development of a program.

APPLICATIONS SOFTWARE

Applications software are specific programs designed by the user to be used, or applied, in solving individual problems or tasks. As stated earlier, a program is defined as a detailed set of instructions. The instructions consist of statements which direct the computer to input data and instructions, to process data arithmetically, to process data logically, to output information, and to control the execution of these functions.

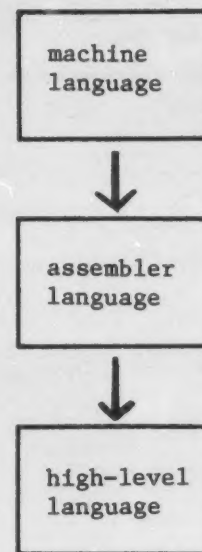
Programs of this type may be written in three levels of languages. These three levels, from lowest to highest, are: (1) machine language,

Software and Development of Programs

(2) assembler language, and (3) high-level language. Machine language, the lowest level, is the basic code of the computer and simulates the use of the binary number system. The binary number system uses only two numbers: 0 and 1. These numbers also represent the presence (positive) or absence (negative) of the electrical charges which are the power source to the computer system. The presence of an electrical charge (positive) is represented by "1," and the absence of an electrical charge (negative) is represented by "0." Therefore, machine language code is determined by the number of positive and negative charges which are sent and the combination.

Assembler language is a level higher than machine language. It consists of symbolic representations of these positive and negative signals and allows for an instruction, such as an input instruction, to be symbolically represented by a group of characters. It is difficult from the programming standpoint because although it uses symbols to represent instructions, it does not simulate the way that we are accustomed to communicate in words.

The next level is the high-level languages. These languages use abbreviations which are the



symbolic representation of instructions. The instructions closely represent the language of the user.

COBOL is a prime example of a high-level language. This language is written using a paragraph and sentence structure similar to the English language.

The major disadvantage of the high-level languages is that they have to be compiled, or translated, into machine language before processing can occur. This process requires a considerable amount of computer time.

The major advantage of the high-level language is its easy use. As one moves from one level to another, the ease of programming increases; however, the amount of time it takes for the computer to operate on the instructions also increases.

SYSTEMS SOFTWARE

In addition to selecting the type of applications software, the user must also determine the type of systems software to be used. Systems software consists of computer programs and a language used to facilitate the operation of the hardware devices by taking care of tasks that routinely have to be undertaken by the user.

The systems software is designed to improve the efficiency of computer operations, to control the execution of application programs, and to manage the data. In most cases the manufacturer of the processing unit provides appropriate systems programming packages, especially in the case of the microcomputers.

The type of systems software package selected is usually determined by the primary uses to be made of the computer system. The intent of all systems software packages is to facilitate the use of a computer system for the user, thereby allowing more time to be spent on developing the applications programming of the computer.

EXAMPLES OF HIGH-LEVEL PROGRAMMING LANGUAGES

There are over two hundred high-level programming languages that may be utilized by computer systems. The selection of a programming language depends on the uses to be made of the computer system and may be limited by the type of program languages offered by the manufacturer. In the case of small microcomputers and some minicomputers, the number of programming languages may be greatly restricted.

Descriptions of four major programming languages, (1) FORTRAN, (2) COBOL, (3) Pascal, and (4) BASIC, are presented in the following discussion. 43

1) FORTRAN

FORTRAN is an acronym for FORMula TRANslator. The language was first developed in 1954 by IBM. The original and primary use of FORTRAN language was to allow mathematicians, engineers, and scientists to take complex mathematical formulas and write them in symbolic languages which could be understood by the computer. The acceptance of FORTRAN by its scientific users was extensive and its applications expanded to business uses.

Because of the widespread use of FORTRAN, a standard was established by the American National Standard Institute (ANSI) to allow programs already written for a particular use to be adapted to other computer systems manufactured by other vendors.

2) COBOL

COBOL (COMMON Business Oriented Language) was developed in 1959. At the request of the Department of Defense, representatives from government and industry created a language appropriate for business applications. The language was standardized by ANSI in 1968 and again in 1974, insuring machine independence; that is, a COBOL program written for one

computer system was adaptable to other computer systems, even those manufactured by other vendors. COBOL is English-like in format and fairly easy to read and understand.

3) Pascal

Pascal is a relatively new language. It was developed in 1968 by Nicolas Wirth for the Federal Institute of Technology in Zurich, Switzerland. The language is especially suited for micro- and minicomputers. Many manufacturers of computer systems are investing millions of dollars in developing Pascal compilers. Pascal is also used on many large computer systems in the educational field. Numerous colleges and universities are adopting Pascal for teaching the principles of computers and the development of applications programs.

4) BASIC

BASIC (Beginners All-Purpose Symbolic Instruction Code) was developed at Dartmouth College in the 1960s. It is used primarily with minicomputers and microprocessors. BASIC is becoming increasingly popular because of its conversational nature and its orientation for instructional purposes. Unfortunately, BASIC programming languages vary from one computer system to

the next; that is, a BASIC program written for one computer may not work on another computer unless modified. Since BASIC has become widely accepted by educators and is readily available with the purchase of almost all minicomputers and microcomputers, ANSI (American National Standard Institute) is in the process of developing a standardized BASIC programming language.

In order to demonstrate the ease in which a program may be written to solve a problem, an applications program using the BASIC language is explained in the following example.

Problem Statement:

A program is to be written to add three examination scores for each student. The student identification number and the total number of earned points will be printed.

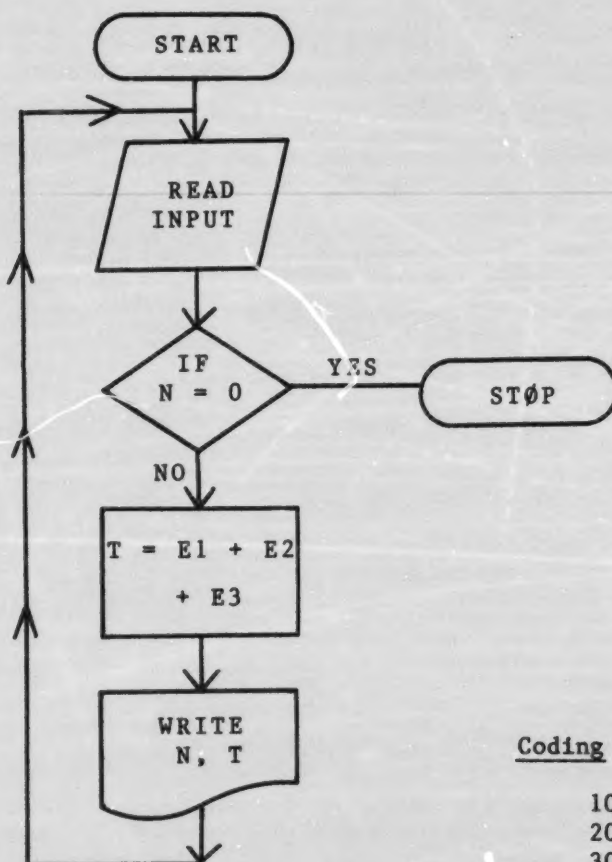
INPUT Record Layout (how the computer will receive the data)

<u>Data</u>	<u>Memory Location</u> <u>Variable Name</u>
Student Number	N
Exam 1 points	E1
Exam 2 points	E2
Exam 3 points	E3

OUTPUT Record Layout

<u>Data</u>	<u>Memory Location</u> <u>Variable Name</u>
Student Number	N
Total points on all three exams	T

Flowchart



Coding

```

100 INPUT N, E1, E2, E3
200 IF N=0 GO TO 600
300 T = E1 + E2 + E3
400 PRINT N, T
500 GO TO 100
600 STOP
700 END
  
```

In the development of a program, the first step is to define the purpose of the program. This statement must explain what the program will do. The programmer must then analyze and design the logic to solve the problem (Step 2). A flowchart is used in this case. A flowchart is simply a diagram using standard symbols to illustrate the type and the order of the instructions needed to solve the problem.

The third step is the actual coding of the program. The programmer writes the appropriate BASIC instruction according to the logic illustrated by the flowchart.

If the sample problem is solved manually, the following steps would be followed:

- Step 1: An identification number is assigned to each student.
- Step 2: The three exam scores for a particular student are added.
- Step 3: The student's identification number and total score are recorded.
- Step 4: The cycle continues until all students are processed.
- Step 5: End processing.

The same steps outlined in the manual method are followed in the computerized method with several additional steps included. The first line of the program is a statement that allows data to

be read and stored in the memory of the central processing unit of the computer. The word "input" is used to execute this command. Following the "input" statement are the characters N, E1, E2, and E3. These characters are the names of the variable data created to represent the student number, examination score one, examination score two, and examination score three.

The next statement in the program is an "IF" statement that allows a question to be asked. This question asks if the student number is equal to zero. Unlike the manual method, the computer needs an instruction to stop executing after it has completed processing the last student. In this sample program, execution will end when zero is stored in the memory location called N. When this situation occurs, the program is directed to "GO TO" another statement that will stop execution.

The "GO TO" statement is an unconditional transfer meaning that the central processing unit should go to the particular line number which is cited (600). The two possible number responses to this question are 1) "yes, the student number is equal to zero," or 2) "no, the student number is not equal to zero." In the flowchart, the symbol used to represent a question is the

diamond. If the response is "yes," the flow-chart indicates that the instructions proceed to the right; that is, to "stop". If the response to the question is "no," the instructions proceed down to the next instruction.

The next line of the BASIC program is an arithmetical instruction assigning a value of $E1 + E2 + E3$ to the variable name T. The computation simply adds $E1 + E2 + E3$ and stores the total in T.

The command "PRINT" followed by the variable names N, T instruct the computer to print out the information (processed data) stored in the memory locations N and T. The first student has now been processed.

To allow the cycle of instructions to be executed for the remaining students, a "GO TO" command followed by a line number directs the computer to repeat the process. The computer will continue this process until it finds a student number equal to zero. (A set of instructions processed in a repetitive manner is referred to as an algorithm.)

The last instruction terminates the execution of this program. Refer to line 2 of the program. The instruction states that if N is equal to

zero, "GO TO" 600. If we have read all of the students' grades and have computed their total, execution will "stop" as indicated by the "STOP" statement. The "END" statement must be the very last line of the program.

This program demonstrates the basic functions (instructions) that the computer can execute: 1) the ability to input, 2) the ability to process logically, 3) the ability to process arithmetically, 4) the ability to output, and finally, 5) the ability to control the order in which the other instructions are executed.

All programs consist of varying combinations of instructions and the multiple use of these instructions. The placement of these instructions depends on the purpose of the program as defined in the problem identification.

STEPS IN DEVELOPMENT OF A PROGRAM

The example of a BASIC program is representative of a symbolic language that may be used in communicating with a central processing unit. The language, whether it be BASIC, COBOL, Pascal, FORTRAN, or any other high-level language, must be coded correctly to work. Equally important as the program language is the logic which orders the placement of these instructions.

In the development of program, there is a series of eight steps that is followed:

1. Problem definition - Identifies the data to be processed (input) and the information to be produced (output).
2. Analysis and design - Determines the steps needed in processing in order to take the given input and produce the desired output.
3. Language selection - Choice of language depends on the type of problem to be solved.
4. Program coding - The actual writing of the program in the selected language.
5. Testing and debugging - Executing the program with test data to insure accuracy.
6. Documentation - Written material which explains to others the purpose of the program, its logic, input data, and expected output.
7. Implementation - The utilization of a program with real data.
8. Maintenance - The process of modifying, up-dating, and reviewing programs to insure optimum operations.



Self-Check

- | | | |
|---|---|--|
| T | F | 1. Applications software is used primarily to undertake the operation of a computer system. |
| T | F | 2. The highest level of applications software is machine language. |
| T | F | 3. For a language to be considered high level it must be restricted to a particular computer system. |
| T | F | 4. FORTRAN language is adapted primarily for business use. |

- T F 5. BASIC language stands for Beginners All-Purpose Symbolic Instruction Code.
- T F 6. Step 1, problem definition, is the most critical step in the development of a program.
- T F 7. The flowchart is depicted as a portion of the problem definition step.
- T F 8 Documentation is important because it enables the user to learn the full use of the program.
-

SECTION VIII

Trends in the Computer Industry

The revolution that is occurring in the computer industry has brought about the use of computers in new areas. Given the reduction in the cost of hardware and the increase in the availability of software, the number (and types) of users has grown significantly! This trend is expected to continue at a steadily accelerated rate.

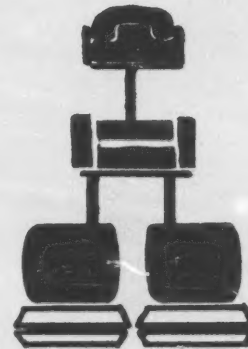
The trends in hardware development have focused on reduction in costs, size and weight. At the same time, speed, reliability and computing power are increasing. Except for the computer, very few products offered by modern industry have shown such marked improvement as their costs decline.

Another important improvement in modern computers is the lifting of the environmental constraints. Until recently, computers, in order to ensure reliable performance, had to be kept in climate-controlled rooms. Newer computers, especially microprocessors, are designed to work almost anywhere. This change represents another cost reduction, saving customers the expense of special climate control equipment.

The use of computer networks is a very important trend. Within business concerns, network configurations (that is, different computers interconnected by communication lines) are used to share the work load among a number of computers. Another advantage to using the network is back-up. If a computer goes down at one location, another machine can pick up the work load. The trend toward distribution processing (or use of computer networks) will be apt to reduce the use of large mainframes while increasing the use of minicomputers.

As the computer field grows, changes will naturally occur. Employment opportunities are certain to shift. Some traditional jobs within this field will change drastically. One such job, that is, a key punch operator, will become almost extinct because the development of new data key entry terminals and the trend toward on-line data collection are increasing. The traditional job of a computer operator is another that will tend to stabilize and probably decline in the future.

There will be growth in the demand for programmers, but there will also be changes in this job category. The switch to purchased software will



tend to cut the demand for systems programmers. Applications programming should, however, grow simply because more and more organizations will be using computers. Here again, however, there will be changes. As programming simplifies, the emphasis will shift from coding to problem-solving applications. Perhaps we will someday be able to say that an accountant with a reasonable amount of computer training can be expected to write better accounting programs than a programmer with no accounting experience.

No major technological advances have ever been brought about without some social problems. For example, mass production is probably responsible for bringing us to our present high standards of living, but mass production has often been blamed for bringing drudgery into the lives of assembly line workers. The modern automobile provided us with unparalleled mobility, but automobiles require space for parking and roads.

We must deal with any problems which arise and find workable solutions; but in solving problems arising from technological achievements, we must be careful not to destroy the advantages we derive from that technology. Technology is neither always right nor always wrong.

Eventually there will exist only a few kinds of endeavor that will not have some sort of computer assistance. The mere existence of computers increases people's capabilities manyfold. By using these powerful machines, we may be able to solve many social and technical problems that now appear overwhelming. At the same time, we need to realize that it is we who will always be in control. The growth in the use of computers will be brought about not by advancements in hardware or software, but through our imaginative applications of the computer as a tool.

SECTION IX

GLOSSARY

This glossary has been developed as a tool for your study in computer literacy. Included are key terms used in this publication. (The terms are typed in all capital letters in the body of the text.) Thus, the glossary can be used as a reference during your reading of the text. Furthermore, additional terms have been provided as aids for your continued study of the world of computers.

ALGORITHM: An orderly step-by-step procedure, like a recipe, that consists of a list of instructions for accomplishing a desired result, or for solving a problem. Usually expressed in mathematical terms. In computer programming, an algorithm is expressed as a flowchart.

ALPHANUMERIC: Data made up of both alphabetic characters, special symbols and numbers.

ANALOG COMPUTER: A computer that solves problems by measuring; that is, by determining the amounts or changes in amounts of physical units such as heat or speed.

APPLICATION: A job processed on a computer to deliver specific results.

ARITHMETIC SECTION: Portion of the central processor that performs addition, subtraction, multiplication, and division.

ARITHMETIC/LOGIC UNIT: That component of the central processing unit where arithmetic and comparison operations are carried out.

ASSEMBLER: A unit of software that accepts English-type statements written by programmers and converts them to machine language instructions usable by computers; assemblers usually convert individual statements by programmers to individual instructions for computer operations.

AUTOMATED DATA PROCESSING: A system whereby data are reused by multiple machines or devices for many jobs or applications once they are captured in a system.

BASIC: A programming language developed in the mid 1960s as an easy to learn, easy to use language to teach students how to program. The language contains a limited set of powerful commands designed especially for use in time sharing environments.

BATCH: A group of data records organized for control over input, processing, and output; data are often grouped for computer input in batches.

BINARY FORM: A system of representing bi-state conditions and/or numeric values usable in computation with the symbols 1 and 0.

BIT: Binary Digit. The smallest unit of digital information. It has only two states: zero and one. A bit can be thought of as representing: a yes/no choice, a distinction between true and false, or whether a circuit is on or off.

BYTE: The basic unit of information in a computer, commonly consisting of a sequence of eight binary bits, or characters. Since most 1980 vintage personal computers use microprocessors that operate one byte at a time, this term is frequently encountered.

CARD READ-PUNCH: A device that can read data into a computer from cards and also punch output information into cards.

CASSETTE RECORDER: A device for preserving internally-stored information. Because most computers lose the information stored in them when they are turned off, a means of keeping the information is necessary. Binary information is stored on a cassette tape by first converting it to audio signals and recording it on the tape. This method of storage is slower than discs.

CATHODE RAY TUBE: A television-like electronic vacuum tube used as a display device for computer terminals.

CENTRAL PROCESSING UNIT (CPU): The device that handles the arithmetic, logic, control, and memory functions of a computer.

CHARACTER: Single items that can be arranged in groups to stand for information. There are two forms: (1) numbers, letters, graphic symbols, etc., that can be understood by human beings, and (2) groups of binary digits that can be understood by the computer. A character is usually represented by one byte.

CHIP: The heart of a microcomputer, a piece of silicon smaller than one's fingernail on which thousands of electronic elements are implanted. Called a microprocessor, it contains all the circuits one needs to carry out the many computer operations.

COBOL: A programming language, an abbreviation for Common Business Oriented Language.

COMMAND: An instruction given to the system through an input device or peripheral. It is executed as soon as it has been received.

COMPATIBILITY: There are two types of compatibility: program and hardware. Program compatibility refers to the ability to run programs on a variety of computers without changing the program language. Hardware compatibility means that various components (printers, discs, keyboards, etc.) may be connected directly without intervening electronic devices and that all components use the same baud rate, word length, and other technical aspects in order to communicate.

COMPILER: A unit of software that accepts English-type programming statements (a source program) and converts them into machine language (an object program) for use by a computer.

COMPUTER: A device that receives and then follows instructions to manipulate information. The set of instructions and the information on which the instructions operate are usually varied from one moment to another. If the instructions cannot be changed, the device is not a computer. The difference between a computer and a programmable calculator is that the computer can manipulate text and numbers; the calculator can manipulate only numbers.

COMPUTER PROGRAM: A set of instructions that direct a computer in completing a specific processing job.

CONTROL UNIT: A portion of the CPU that controls processing functions.

CONVERSION: The procedures for changing from one data processing system to another. When a new computer system is started up, conversion is the point at which the old system is replaced with the new one.

COURSEWARE: A combination of content, instructional design, and the software which causes a computer to implement instructions.

CRT: Abbreviation for cathode ray tube, a TV-like display used in computer terminals; also used to describe a keyboard-operated terminal with a video display.

DATA: Numbers, symbols, or letters that have meaning and can be processed to produce information.

DATA PROCESSING: A series of steps followed in accepting and processing data to deliver information.

DEBUG: To find and correct errors in the coding of a program.

DIGITAL COMPUTER: A computer that solves problems by counting; that is, by adding, subtracting, multiplying, or dividing numbers.

DISK (DISC): A round, flat device used for storage of data; surface is coated with a ferrous material for magnetic recording of data. Commonly found are floppy and hard disk systems.

EXECUTE: The running of a computer program.

FILE: A collection of related data records stored in a set order for reference and use; data files are stored, retrieved, and processed automatically within computer systems.

FLOPPY DISK: A flexible plastic disk on which data are stored magnetically.

FLOWCHART: A document that shows, through the use of standard graphic symbols, the step-by-step procedures to be followed in a data processing system.

FORTRAN: High-level programming language developed in 1957 and designed to translate mathematical formulas into computer code.

HARDCOPY: Data or information printed on paper. Used to distinguish between printed information and the temporary image found on the CRT.

HARDWARE: Any piece of equipment that is part of a data processing system or any complete computer installation.

HIPO CHARTS: An acronym which stands for Hierarchy plus Input Processing Output. It is both a design tube and an aid to program documentation that is concerned with what is done rather than how a particular activity is accomplished.

INFORMATION: Processed data; computers accept raw data and produce information--facts and figures organized in useful form.

INPUT: Data that are put into a computer system for processing; also the activity for entering data into the computer.

INPUT DEVICES: Category of hardware which performs the function of capturing or obtaining original data and placing it into the data processing system.

INPUT MEDIA: Any materials or devices used to capture data and enter them into a computer; included are punched cards, magnetic tape, cassettes, disk packs, and diskettes.

INTELLIGENT TERMINAL: Terminal with built-in programmable intelligence enabling it to pre-process information and/or instructions without the aid of a CPU.

INTERACTIVE: A term describing operations in which a computer is responsive to inputs from people using terminals; the computer interacts with users.

INTERFACE: An electronic circuit used to connect one electrical device to another electrical or mechanical device to allow the flow of data between units. It refers to the matching or interconnecting of systems or devices having different functions.

INTERNAL OR PRIMARY MEMORY: Storage area within a computer that serves for temporary storage of programs and data during program execution. Also known as main memory or internal memory storage.

KEYBOARD: A device for typing information into a computer. It is similar in design and function to a typewriter keyboard. The computer keyboard has several additional keys for specific computer functions.

KEYPUNCH: A data conversion machine, operated from a keyboard, used to capture data into punched codes in cards for computer input.

KILOBYTES or KILO or K: The Greek prefix meaning 1000. When used by computationists, K means 1,024; thus a 64K memory contains 64 x 1,024 or 65,536 bytes of memory storage capacity.

- LOGIC, PROCESSING:** Functions of the central processor of a computer for comparing or sensing conditions of data items and applying processing steps according to the status or condition of data items.
- MACHINE LANGUAGE:** A term that describes the coding, in binary format, that operates computer systems; programs must be in machine language before they can be run on computers.
- MAGNETIC DISK:** A flexible, light plastic or metal disk covered with a ferrous oxide coating on which data may be stored magnetically.
- MAGNETIC TAPE:** A coated plastic tape used for magnetic recording of data; tape is limited to sequential storage of data.
- MAINFRAME:** A central computer; includes the CPU and supporting equipment, usually including an operator console; term is usually used for medium- and large-scale computer systems.
- MEMORY:** A device within a computer system that records data and information in support of processing functions.
- MICROCOMPUTER:** A small computer system that usually fits on a desk top; processing capabilities are usually limited to the handling of one job at a time.
- MICROPROCESSOR:** A small device, usually a miniature circuit chip, on which processors are built; microprocessors are used in many electronic devices, including computers.
- MINICOMPUTER:** A computer having a smaller capacity for both primary and secondary storage than medium-size and large-size computers.
- OFF-LINE:** A term indicating that a unit of equipment is not connected directly to a computer.
- ON-LINE:** A term indicating that a unit of equipment is connected directly to a computer.
- OUTPUT:** A result of computer processing; may be in the form of video display, printed material, or data recorded on storage media.
- PRIMARY STORAGE:** Another name for computer memory; indicates a device that stores data within the CPU.
- PRINTER:** Any device, on-line or off-line, that converts computer output to printed documents.
- PRINTOUT:** Output from a computer system in printed form.
- PROCEDURE:** A task or set of steps for the processing or use of data.
- PROCESSING:** The manipulation of source materials to produce results, as in the handling of data to deliver information.

PROGRAM: A series of instructions prepared for a computer which control its operations and functions.

PROGRAMMER: A person who prepares computer programs.

PROM: Programmable Read Only Memory. Computer memory chips that can be programmed permanently by burning the circuit in patterns to carry a predefined process.

PUNCHED CARD: A card used for encoding data in machine-readable format for computer input or as a form of output; coding is in the form of holes in the cards.

RANDOM ACCESS MEMORY (RAM): A system that permits direct access to any record in a memory or storage device.

RAW DATA: Data that have not yet been processed; also called source data.

READ-ONLY MEMORY (ROM): A high-speed memory device from which pre-recorded data can be read; new data cannot be written into ROM; usually used to store such software routines as monitors or operating systems.

REMOTE TERMINAL: A terminal that is located at a distance from a computer system and may be connected to the computer by communication lines.

RESPONSE TIME: The interval of time required for the microprocessor to respond to an instruction or an input from a peripheral such as the keyboard. In an educational environment, the time interval from the activation of the keyboard to a display on the CRT should be less than three seconds.

RPG: Non-procedural programming language used for many business applications.

SECONDARY STORAGE: Data storage that is located in a place other than in the central processor.

SEQUENTIAL ACCESS: A system in which data must be recorded and read to or from storage media in a given order; magnetic tape is a medium that can be processed only with sequential access.

SOFTWARE: A term that describes all programs that control either computer operation or the processing of applications.

STORAGE: A term describing a device or procedure for use by a computer system; storage devices are computer peripherals.

SYMBOLIC PROGRAMMING: A programming system based upon the use of graphic codes or special symbols.

SYSTEM: A group of procedures, people, materials, and equipment that follow a pattern of activity to produce known results.

TAPE DRIVE: A peripheral device that reads data from or records data onto magnetic tape.

TAPE REEL: A plastic reel, and cover, used for storing magnetic tape.

TEMPLATE, FLOWCHARTING: A plastic device used to draw precise outlines of symbols used in flowcharting computer systems or programs.

TERMINAL: A user work station that may be connected to a computer system for input or output operations.

TIME SHARING: A system within which more than one terminal can process input and output to a computer system at the same time.

USER: A person or organization using the results of computer processing; refers also to a person who interacts with a computer through an on-line terminal.

VIDEO OUTPUT: An output in the form of a display on a cathode ray tube terminal.

WORD PROCESSING: A system for processing text materials in which input files are stored for later correction and use, eliminating later retyping; can be done on computers or on special electronic equipment.



ANSWERS TO SELF-CHECKS

Section I

1. False
2. True
3. True

Section II

1. False
2. False
3. True

Section III

1. False
2. False
3. True

Section IV

1. True
2. False

Section V

1. False
2. True
3. True
4. False
5. True
6. True
7. True
8. True
9. False

Section VI

1. True
2. False
3. False
4. False
5. True
6. True

Section VII

1. False
2. False
3. False
4. False
5. True
6. True
7. False
8. True



History of Computers

HISTORY OF COMPUTERS*

In terms of age, the computer can be thought of as a rather new development. Computers have been used in business and industry less than thirty years. Yet, there have been many great improvements in computer technology during this fairly short period of time.

COMPUTER GENERATIONS

Each major improvement in technology has led to the development of a new "generation" of computers. Since the use of the first computer in the early 1950s, three--some say four--different generations of computers have been developed. The announcement of the fourth generation of computers can be expected almost any time. In fact, some manufacturers already state that their latest computers are of the fourth generation. But, there is yet no industry agreement on this.

Each new generation of computers improved input/output and memory devices. The new input/output devices made it possible for the user to have much greater kinds of input media. Also, the data in these media could be recorded and processed at far greater speeds. The improved memory devices were not only smaller in size, but they were able to store more data in less space. These changes made it possible to increase the internal processing speed of a computer about ten times with each new generation of computers.

*The information presented in this section was extracted from FUNDAMENTALS OF DATA PROCESSING by S.J. Wanous, Gerald E. Wagner, and Judith J. Lambrecht (South-Western Publishing Company, 1981, pages 138-140).

FIRST-GENERATION COMPUTERS

The first-generation computers used vacuum tubes for memory circuitry. For this reason, the machines were very large in size and fairly slow by today's standards. First-generation computers could make over 100,000 calculations per second. Although this may seem extremely fast, the GUINNESS BOOK OF RECORDS lists the speed of a modern Control Data Corporation at almost 100 million calculations per second in 1976. The large number of vacuum tubes in these early computers created many problems because of the amount of heat generated by the tubes. This heat problem made it necessary to install heavy-duty air conditioning units. The first-generation computers were mostly computational machines. Their input/output capabilities were usually limited to keyboard and/or punched card input and printer and/or punched card output.

SECOND-GENERATION COMPUTERS

The second-generation computers used transistors in place of the vacuum tubes. This change made it possible to reduce the amount of heat put out by the machines. The use of transistors also made it possible to reduce the size of the equipment. This change further increased the computer's computational speed. Also, the transistors proved to be much more reliable than vacuum tubes.

Removable disk storage units and magnetic tape input/output units were developed for use on these machines. The speed of the line printers was increased from 300 lines per minute, which was fairly common on first-generation computers, to 1,000 per minute. The speed of card readers and card punches was also increased, although not as dramatically as that of the printers. These changes in the computer made it more useful as a

tool in business because of the large volume of data to be processed and the lengthy printed reports required.

THIRD-GENERATION COMPUTERS

The third-generation computers used very small electronic circuits called microcircuits rather than transistors. This change further decreased the size of the computer while increasing its speed. The speed of the first-generation computers was described in milliseconds ($1/1,000$ of a second). The speed of the second-generation computers was described in microseconds ($1/1,000,000$ of a second). The speed of the third-generation computers was described in nanoseconds ($1/1,000,000,000$ of a second). The speed of line printers on many third-generation computers was increased to 2,000 lines per minute. One computer manufacturer has developed a printer that has rated speed of over 20,000 lines per minute.

An abstract geometric line drawing composed of numerous thin black lines. The lines intersect to form a complex web of triangles and polygons of various sizes. Some lines are parallel, while others converge towards a point, creating a sense of depth and perspective. The overall effect is a dynamic, non-representational composition that fills the lower two-thirds of the page.

Future Uses of Computers

FUTURE USES OF COMPUTERS*

Science fiction is rapidly evolving into fact. The computer has your number and may even be watching you. It is safe to assume that there is no aspect of human life that is not in some way affected by behind-the-scenes computers. A computerized society is no longer just a possibility: it is almost here today.

Automation will continue to grow as a way of life because people will always devote much of their efforts to finding new ways to accomplish or circumvent monotonous and laborious tasks, especially those not requiring their full abilities as human beings. Have you ever wondered what life will be like in the year 2001? This author believes that automation will play an almost unbelievable part in everyone's life.

Do you believe that unmanned ships will sail across the Atlantic and Pacific in 2001? Science fiction or logical possibility? Considering the inherent risks involved in making predictions, it might be safe to say science fiction. However, because it is stimulating to speculate about the unknown, and also because there is some security in this age of rapidly changing technology, this author calls it a logical prediction (assuming that no nuclear war occurs beforehand).

Let us now examine what life may be like in the year 2001. Many of these predictions will undoubtedly prove to be in error, but perhaps they will show us how the evolving use of computers may affect our lives.

*The information presented in this section was extracted from DATA PROCESSING: AN INTRODUCTION by Donald D. Spencer (Charles E. Merrill Publishing Company, 1978, pages 376-386).

TRANSPORTATION

It was just 24 hours and a few minutes since he had left the shores of Italy; now the ship's captain saw the skyline of New York City before him. Soon, harbor control would assume control of his giant merchant ship. Automatically, the ship would be guided at high speeds through the ship channel to the docking and unloading center. Here the ship would be completely unloaded by means of a computer-controlled unloading system directly onto transportation devices for immediate shipment to various points throughout the United States. The unloading operation would take two hours. Within an additional two hours, the ship would be on its way back to Europe or some other destination, fully loaded with cargo, streaking across the ocean at better than 100 knots without a crew busy at its controls. This was the last of the manned trips. The computer would be in complete control of the ship on all future voyages. Using inputs from radars, satellites, sonars, and other navigational equipment, the computer would control ship operations as an electronic captain. The year is 2001--the age of automated transportation systems.

Ships now communicate with shore stations and other ships by using satellites in synchronous orbits (approximately 20,000 nautical miles above the earth). Each of these satellites is a view of one-third of the earth's surface. Shipowners now monitor the operations of their complete fleet. Their computer-controlled display consoles reveal at a glance the locations and status of all ships. The ship's position (latitude and longitude), speed, course, remaining fuel, engine status, electrical system status, cargo status, and weather conditions are all communicated to the computer system every few minutes. It performs a few calculations and updates the ship position on the display console. Gone are the days when a ship is "lost at sea".

Surface transportation systems are now available that permit speeds of 250 mph through densely populated cities. Computers are used to design, test, and run these systems. Their bullet-shaped vehicles produce almost no pollutant by-products and are relatively vibration-free. Some of them are equipped with LIM (Linear Induction Motor) motors, which have no wearing parts like gears or bearings. The LIM is operated on alternating current created by electromagnetic fields.

Computers now handle most of the operating details of jetliners, allowing the captain of the ship to keep watch only for unusual occurrences. Computers switch equipment on and off, control aircraft centers of gravity, communicate with other airplane computers enroute, determine the plane's automatic takeoffs and landings. The onboard computer takes account of winds, storm, temperature, and other aircraft. When landing, the computer automatically adjusts the speed and angle of descent of the plane so that a perfect landing can be made without any action on the pilot's part. Maintenance computers give advance notice of needed repairs or replacement of aircraft components and have practically eliminated flight delays or cancellation of flights because of mechanical problems.

Computers have made flying in the year 2001 very safe. They have minimized the possibility of mid-air collisions. They keep track of planes in the same air corridor and calculate the distance between, and direction of, all of them. If the speed and direction of any two planes indicate that a collision is likely, the computer alerts the pilots to the fact that instructions are being prepared to avoid the danger. Within seconds, the computer will advise the pilots what corrective maneuvers to take.

As the passenger stands in front of the automatic vendor, he or she is quickly guided through the necessary steps to purchase a ticket by a series of computer-controlled lighted instructions that are sequentially illuminated. During the few seconds it takes for the machine to encode, print, and bond the ticket, the instruction "Please wait for ticket" is displayed.

MEDICINE

In 2001 all large hospitals are using centralized computer systems to perform a large amount of patient care. A patient entering the hospital is admitted, diagnosed, and monitored by the computer. Electroencephalogram (brain-wave recording) analysis is performed by computer. Electrocardiograms (heart waveforms) are read and interpreted accurately by computer. Phonocardiograms (heart sounds and murmurs) are processed and analyzed by computer. The timing and relative amplitudes of heart sounds are displayed on CRT display, along with the onset, duration, relative amplitudes, and relative frequency information of any systolic or diastolic murmurs which have been detected.

Most doctors have display terminals connected to medical information banks for consultation purposes.

You are able to "dial the doctor" and be connected to a medical computer system which can make a first-level medical diagnosis. This system asks questions, prescribes medication, and gives instructions on whether to go to the hospital emergency room immediately or to your family doctor or clinic tomorrow. Some medical systems even have access to your own medical history.

Computers have helped stamp out all forms of diseases so that people now enjoy healthier, more satisfying lives.

In 2001, robots will be walking, making decisions, and thinking, as it were, for themselves. Their minds are composed of programmed computers. They use television-like cameras for eyes to send inputs to the computer. For example, if a robot on an exploration trip bumps into an obstacle which it has not previously sensed, the television camera and cat-whisker antennas (wire sensors) send data to the computer that in effect ask, "What do I do now?" The computer then switches to an "I'll-walk-around-it" or a "Let-me-take-a-look" program.

Domestic robots are available to perform a variety of routine household chores. These chores include preparing some meals, mowing the lawn, cleaning up after meals, babysitting, washing clothes, and watering plants.

Robots are used to perform tasks that are boring, dangerous, or have to be performed in hostile environments, such as the floor of the ocean.

When NASA sends a space vehicle to Mars, robots will be the first to explore this dangerous terrain. The temperature of the surface of Venus is about 800°; Jupiter has a poisonous atmosphere and crushing gravity; pressures on the bottom of the ocean can crush vessels with steel hulls several inches thick. People are unable to explore these areas, but robots impervious to heat, poisons, and pressure are able to.

Mobile robots are widely used in industry to perform operations in various manufacturing processes.

COMPUTERS IN THE HOME

A typical new home in 2001 is similar to that of Mr. and Ms. Universe. This home contains three bedrooms, a family room, a kitchen, two bathrooms, and a large play room. Located in the kitchen is a family control center, the heart of which is a computer. There is a keyboard input device, a voice recognition device, and a display device. Ms. Universe (or Mr. Universe, if he's the family cook) uses the center to conjure up nutritionally balanced, tasty, eye-pleasing meal plans. She simply supplies the computer with an appropriate code for any of several major food categories. The computer then causes a printout with a full dinner menu planned around entrees such as ham, beef, chicken, trout, lobster, veal, lamb, pork, game, eggs, and cheese. For finicky or allergy-prone diners, substitutions can be obtained by entering additional costs. Ms. Universe is always free to place new menus in the computer's memory.

Ms. Universe also uses the center for typing her shopping lists, writing letters, calculating requirements for drapery material, obtaining suggestions for rearranging room furniture, keeping track of the household budget, and ordering grocery and clothing items from the computerized store.

Mr. Universe uses the computer to keep track of his investments, to prepare tax reports, to take a course in business law, to take care of his checkbook accounting, and to solve problems related to his work. For example, he can use the computer to prepare budgets and manpower forecasts for his different business projects. He, like the rest of the family, may also use the computer in his spare time to learn, say advanced psychology. The computer retrieves from its memory a teaching

program for advanced psychology, remembering where the student left off at the end of the last lesson. The psychology lessons are programmed to proceed at just the pace that matches a student's learning rate.

The computer center can drive clocks throughout the house, control the air-conditioning and heating system, change television channels at predetermined times, control the stereo music center, open and close doors and windows, and perform family medical diagnoses.

The Universe children, Mars and Space, can also use the computer center. Mars is in elementary school and checks all his arithmetic and language problems by computer. Space who is in college, can use the computer as a homework aid in practically all her courses. When their lessons are done, the children can play a game of tic-tac-toe, blackjack, chess, space war, or football with the computer.

What does the home computer cost? Less than \$1000, which includes all the electronic control and communication devices that are connected to the computer.

FINANCE

Paper money and coins are all found in "money collections." People are paid by check, and these checks are automatically deposited into checking accounts. Any amount that you owe the Internal Revenue Service in taxes will disappear out of your account before you have a chance to see it.

In making purchases, you will use a single "universal credit card." Inserting the card in a slot at a store or business will remove funds from your account and deposit them into the account of the business. Most banks also provide self-service banking.

EDUCATION

In 2001, small classroom computers are common in all schools--elementary, secondary, and college. Students learn to program computers at an early age and use them throughout their educational careers. Since most families own a home computer, students are expected to use theirs to help them with homework. Computer-Assisted Instruction (CAI) in which the computer presents tutorial and drill practice information to the student, is a feature of all schools. For example, you may engage in the following conversation with a computer. The underlined remarks are yours:

HELLO

HI

HOW ARE YOU THIS MORNING?

FINE. HOW ARE YOU?

OK. ARE YOU BUSY TODAY?

FAIRLY BUSY. I AM COMMUNICATING WITH 1263 USERS RIGHT NOW.

WILL YOU HELP ME WITH A PROBLEM?

OF COURSE. TELL ME THE PROBLEM.

I HAVE AN ITEM IN MY STORE THAT COSTS \$18. TELL ME THE SELLING PRICE

I SHOULD CHARGE SO I WILL HAVE A PROFIT OF 12% OF THE SELLING PRICE.

\$20.45. DO YOU WANT TO KNOW HOW I COMPUTED THIS ANSWER?

NO THANKS. YOU TOLD ME WHAT I WANT TO KNOW.

DO YOU HAVE ANOTHER PROBLEM?

YES. WHAT SHOULD I BUY MY MOTHER-IN-LAW FOR HER BIRTHDAY?

SORRY. I DO NOT GET INVOLVED WITH IN-LAW PROBLEMS. DO YOU HAVE

ANOTHER PROBLEM?

NO. GOODBYE FOR NOW.

SO LONG.

The computer almost seems literally to understand what you want. It does not really, because the computer has been programmed to give the proper response. Nevertheless, you are now able to have realistic conversations with the computer.

INFORMATION SYSTEMS

Computers linked to common information banks are now common in law and medicine as well as in educational institutions. Criminal justice information systems allow all allied organizations to share information, expand local data files, and analyze interdependent problems, such as manpower utilization and court docketing. Medical information systems provide doctors and hospitals with a central source of up-to-date data concerning all known diseases and medical procedures. School terminals connected to a central educational system allow access to vast amounts of general information. Book libraries have become obsolete for obtaining such information.

You can "dial the encyclopedia" and obtain rapid access to a body of factual information at least as large as a good current encyclopedia. The requests are spoken, and the response is either spoken or displayed on a visual device.

You can also "dial the store" and obtain delivery on thousands of items from peanut butter to sirloin steak (which now costs \$14.50 per pound) to sandpaper to furniture. Thus, you will be able to shop by catalog and obtain the bulk of your needs without leaving your home.

Hotels use computerized systems to keep track of room reservations, hotel personnel, disposable items, and food and beverage items and to compute customer bills upon checkout.

Information banks are available that contain detailed information on available positions and persons seeking employment. These systems cover jobs at all levels and are a major method of the government in the analysis and control of the economy.

Law enforcement agencies use computer systems to identify criminals (by fingerprints, voiceprints, pictures, and handwriting) as well as to obtain instantaneous information on stolen items, traffic violations, and so forth.

You have a wide choice over what you hear or watch on your home entertainment center. You can watch the news, a sporting event, a musical play, a travelog, an educational program, a soap opera, or a movie. You can dial programs you have missed or those you would like to see again. You can even select the commercials that you want to watch. You can also just listen to a good musical program. The cost? You pay by the program, and the computer, of course, automatically deducts the proper costs from your banking checking account.

Entertainment parks, such as Disney World in Orlando, Florida, use computers to control rides (like Space Mountain) and to move the arms, legs, ears, and eyes of all their animated characters.

SPACE

In the year 2001, there will undoubtedly be a sizeable computer-controlled operation on the moon, and it is entirely possible that people will have flown to the outer planets. A manned Mars landing may even occur by the turn of the century.

MISCELLANEOUS

Cities in 2001 are designed with the aid of computers. Mathematical models of atmospheric pollution patterns are used to predict where heavy industry and new population centers should be located to minimize environmental damage and optimize healthful living conditions. Small computers, about the size of a watch, have become available to everyone. These computers cost only about \$50 (at the dollar's current value).

Computers are able to analyze a person's voice, handwriting, fingerprints, and even picture and to make a positive identification.

Computers are used to combine voice analysis and language translation into a translator device for conversation in two different natural languages. These translation devices are used primarily by tourists, businessmen, and scientists.

The cause-and-effect relations of weather are now understood, and computers are used to accurately analyze and predict the weather as well as explore ways to modify weather patterns.

Supermarkets now use computer systems to keep track of inventory and to speed up the food checkout process.